

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Kwang Su Choe, et al.

Examiner: Unknown

Serial No.: 10/674,647

Art Unit: 1762

Filed: September 30, 2003

Docket: YOR920030293US1 (16818)

For: THIN BURIED OXIDES BY LOW-DOSE
OXYGEN IMPLANTATION INTO MODIFIED
SILICON

Dated: October 11, 2007

Confirmation No: 4796

Mailstop Amendment
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

DECLARATION PURSUANT TO 37 C.F.R. 1.131

Sir:

We, Kwang Su Choe, Keith E. Fogel, Siegfried L. Maurer, Ryan M. Mitchell and
Devendra K. Sadana hereby declare that:

1. We are co-inventors of the subject matter described and claimed in the above-identified patent application.
2. Prior to December 20, 2002, which is the effective filing date of U.S. Patent No. 6,800,518 to Bendernagle et al., we have conceived and reduced to practice a semiconductor structure including a buried oxide layer in accordance with claims 1, 23 and 24 of the above-identified patent application.
3. As evidence of conception and reduction to practice referred to in paragraph 2 above, we have annexed hereto Exhibit A and Exhibit B. Exhibit A is a true copy of IBM invention

disclosure YOR820010417, which was created prior to December 20, 2002. Exhibit B is a true copy of IBM invention disclosure YOR820010812, which was also created prior to December 20, 2002. Each of Exhibit A and Exhibit B teaches the basic features of the invention as claimed in claim 1, claim 23 and claim 24, including in particular the claimed oxygen implant dose of less than $10E17$ oxygen ions per square centimeter. Electron Micrographs attached are part of Exhibit B, all names and dates have been redacted in the preparation of this declaration.

4. We do hereby declare that all statements made herein of our own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under 18 U.S.C. § 1001, and that such willful statements may jeopardize the validity or enforceability of the patent.

Dated

Kwang Choe

Dated

Keith E. Fogel

Dated

Siegfried L. Maurer

Dated

Ryan M. Mitchell

Dated

Devendra K. Sadana



Disclosure YOR8-2001-0417

Prepared for and/or by an IBM Attorney - IBM Confidential

"A"

Required fields are marked with the asterisk (*) and must be filled in to complete the form.

*Title of disclosure (in English)

A near zero oxygen dose SIMOX

Summary

| | |
|------------------------------|--|
| Status | Final Decision (File) |
| Final Deadline | |
| Final Deadline Reason | |
| Merged Disclosures | YOR8-2001-0812 |
| Docket Family | YOR9-2003-0293 |
| *Processing Location | Yorktown |
| *Functional Area | select (700) 700 Isaac-Systems, Technology & Science |
| Attorney/Patent Professional | |
| IDT Team | select |
| Submitted Date | |
| *Owning Division | select RES |
| Incentive Program | |
| Lab | |
| *Technology Code | |
| PVT Score | 71 |

Inventors with a Blue Pages entry

Inventors:

| Inventor Name | Inventor Serial | Div/Dept | Inventor Phone | Manager Name |
|---------------|-----------------|----------|----------------|--------------|
| | | | | |

> denotes primary contact

Inventors without a Blue Pages entry

IDT Selection

Attorney/Patent Professional
IDT Team

Response Due to IP&L

***Main Idea**

1. Describe your invention, stating the problem solved (if appropriate), and indicating the advantages of using the invention.

To produce low cost SOI substrate by anodic etching epitaxial silicon growth and oxidation. First, select a silicon substrate and form a layer of porous silicon on the upper surface. Then, treat the very top surface of the porous silicon with hydrogen to form a layer of single crystal silicon. Then form an epitaxial silicon layer of a desired thickness. Heat the structure in an oxidizing ambient to induce internal thermal oxidation of the porous region to create a buried oxide layer and at the same time a SOI structure.

2. How does the invention solve the problem or achieve an advantage, (a description of "the invention", including figures inline as appropriate)?

No ion implantation or bonding is necessary to form an SOI substrate. A wide range of the insulator thickness can be formed for example in the range from 100 Å to 2 microns.

3. If the same advantage or problem has been identified by others (inside/outside IBM), how have those others solved it and does your solution differ and why is it better?
Current practice is to use oxygen implantation or bonding to create SOI.

4. If the invention is implemented in a product or prototype, include technical details, purpose, disclosure details to others and the date of that implementation.
not reduced to practice at this time.

Critical Questions (Questions 1-9 must be answered in English)**Question 1**

On what date was the invention workable?

Please format the date as MM/DD/YYYY

(Workable means i.e. when you know that your design will solve the problem)

***Question 2**

Is there any planned or actual publication or disclosure of your invention to anyone outside IBM?

☐ Yes

☒ No

If yes, Enter the name of each publication or patent and the date published below.

Publication/Patent:

Date Published or Issued:

Are you aware of any publications, products or patents that relate to this invention?

☒ Yes

☐ No

If yes, Enter the name of each publication or patent and the date published below.

Publication/Patent: Cannon patent on using porous silicon to make SOI wafers (Yonehara et al.).

Date Published or Issued: 3 or 4 years ago.

***Question 3**

Has the subject matter of the invention or a product incorporating the invention been sold, used internally in manufacturing, announced for sale, or included in a proposal?

☐ Yes

☒ No

Is a sale, use in manufacturing, product announcement, or proposal planned?

☐ Yes

☒ No

If Yes, Identify the product if known and indicate the date or planned date of sale, announcements, or proposal and to whom the sale, announcement or proposal has been or will be made.

Product:

Version/Release:

Code Name:

Date:

To Whom:

If more than one, use cut and paste and append as necessary in the field provided.

***Question 4**

Was the subject matter of your invention or a product incorporating your invention used in public, e.g., outside IBM or in the presence of non-IBMers?

☐ Yes
☒ No

If yes, give a date. Please format the date as MM/DD/YYYY

***Question 5**

Have you ever discussed your invention with others not employed at IBM?

☐ Yes
☒ No

If yes, identify individuals and date discussed. Fill in the text area with the following information, the names of the individuals, the employer, date discussed, under CDA, and CDA #.

***Question 6**

Was the invention, in any way, started or developed under a government contract or project?

☐ Yes
☒ No
☐ Not sure

If Yes, enter the contract number

***Question 7**

Was the invention made in the course of any alliance, joint development or other contract activities?

☐ Yes
☒ No
☐ Not Sure

If Yes, enter the following:

Name of Alliance, Contractor or Joint Developer

Contract ID number

Relationship contact name

Relationship contact E-mail

Relationship contact phone

***Question 8**

Have you, or any of the other inventors, submitted this same invention disclosure or similar invention disclosure previously?

☐ Yes
☒ No

If Yes, please provide disclosure number below:

***Question 9**

Are you, or any of the other inventors, aware of any related inventions disclosures submitted by anyone in IBM previously?

☐ Yes
☒ No

If Yes, please provide the docket or disclosure number or any other identifying information below:

Question 10

What type of companies do you expect to compete with inventions of this type? Check all that apply.

- ☒ Manufacturers of enterprise servers
- ☒ Manufacturers of entry servers
- ☒ Manufacturers of workstations
- ☒ Manufacturers of PC's
- ☐ Non-computer manufacturers
- ☐ Developers of operating systems
- ☐ Developers of networking software
- ☐ Developers of application software
- ☐ Integrated solution providers
- ☐ Service providers
- ☒ Other (Please specify below)
semiconductor wafer suppliers

Question 11

If the invention relates to a product or service that is outside the scope of your business unit, please recommend IBM business unit(s), IBM location(s) or individual(s) within IBM that you think would provide a good evaluation of your invention:

*Patent Value Tool (Optional - this may be used by the inventor and attorney to assist with the evaluation)

(The Patent Value tool can be used by the inventor(s) to determine the potential licensing value of your invention.)

Market

*Question 1: What is the anticipated annual market size (in dollars) that will be captured by your invention?

Greater than \$5B

Reason(s) for above Answer:

Claims

*Question 1: How new is the technical field?

Future

Reason(s) for above Answer:

*Question 2: How central is the invention to the product(s) which might be expected to contain the invention?

Entire Product

Reason(s) for above Answer:

*Question 3: What is the scope of the claim?

Broad

Reason(s) for above Answer:

Portfolio Need

*Question 1: What are the portfolio needs in the area of your invention?

Listed in PPM Needs

Reason(s) for above Answer: PPM 100 A4

Exploitation & Enforcement

*Question 1: How easily can the use of the invention by a competitor be detected?

With work

Reason(s) for above Answer:

*Question 2: How easily can the use of the invention be avoided by a competitor?

With much work

Reason(s) for above Answer: the process is low cost

Business Value

*Question 1: What percentage of the companies producing products in the field of this invention might use this invention?

Broadly cloned

Reason(s) for above Answer:

*Question 2: What is the value of this patent to current or anticipated Alliance Activity between IBM and other companies?

High value

Reason(s) for above Answer:

*Question 3: What is the value of this patent to current or anticipated Technology Transfer Activity between IBM and other companies?

High value

Reason(s) for above Answer:

*Question 4: Does it result in prestige to IBM?

Industry wide

Reason(s) for above Answer:

Final Decision

This decision was entered by **Kathy Cognatello/Watson/IBM** on:

| | |
|--|--------------------|
| Decision: File | Status: N/A |
| PPM Area: 100 - Solid State Technologies | Attorney Rating: 2 |
| Date of Final Decision : | |

Additional filing information

Planned Filing date:

Filing comments:

Additional decision comments

Final Decision History

Entered on 5

Merged Disclosures: YOR8-2001-0812

Post Disclosure Text & Drawings

To add additional information related to this disclosure once it has been submitted, click the action button below and a new document will be opened for you to enter the new information. To view existing post disclosure information, double-click on the item in the list below (if there has been additional information entered), and the document will open for you to view.

Date entered Post disclosure information (comments and drawings)

Form Revised



Disclosure YOR8-2001-0812

Prepared for and/or by an IBM Attorney - IBM Confidential

" B "

Required fields are marked with the asterisk (*) and must be filled in to complete the form.

*Title of disclosure (in English)

Thin Buried Oxides by Oxygen Implantation into Modified Silicon

Summary

| | |
|------------------------------|--|
| Status | Final Decision (File/Merge) |
| Final Deadline | |
| Final Deadline Reason | |
| Primary Disclosure | YOR8-2001-0417 |
| Docket Family | YOR9-2003-0293 |
| Processing Location | Yorktown |
| *Functional Area | select (700) 700 Isaac-Systems, Technology & Science |
| Attorney/Patent Professional | |
| IDT Team | select |
| Submitted Date | |
| *Owning Division | select RES |
| Incentive Program | |
| Lab | |
| Technology Code | |
| PVT Score | 71 |

Inventors with a Blue Pages entry

Inventor

| Inventor Name | Inventor Serial | Div/Dept | Inventor Phone | Manager Name |
|------------------------------------|-----------------|----------|----------------|--------------|
| <div>denotes primary contact</div> | | | | |

Inventors without a Blue Pages entry

IDT Selection

Attorney/Patent

Professional
IDT Team
Response Due to IP&L

***Main Idea**

1. Describe your invention, stating the problem solved (if appropriate), and indicating the advantages of using the invention.
Thin continuous buried oxides ($< 300\text{\AA}$) are extremely difficult to fabricate by conventional methods, such as SiMOX or wafer bonding. There is no known demonstration of such layers in prior art to our knowledge. High surface energy associated with the formation of such oxides tend to make them ball up during their fabrication resulting in a discontinuous and fragmented oxide layer.

The present invention overcomes this difficulty by a novel method which includes the following steps: (i) treating the surface of a Si substrate by a process which creates high concentration of vacancies and voids in the surface region, (ii) growing a single crystal Si layer above the treated surface, (iii) implanting oxygen into the novel structure, and (iv) annealing the implanted samples at high temperatures ($> 1100^\circ\text{C}$). Continuous buried oxide layers of $< 500\text{\AA}$ can be created controllably by this method.

We now describe details of each step. For step (i) anodic oxidation of Si is performed in a HF(49%) or HF/ethanol electrolyte such that a very low density porous-Si, or highly vacancy rich Si layer is created. The thickness and porosity of this layer can be controlled by a number of parameters, such as the total current flow during anodic oxidation/etching, time, HF concentration, HF/ethanol ratio, Si substrate doping and doping concentration etc. For step (ii) conventional Si epitaxial reactors such as those made by ASM or Applied Material can be used. For step (iii) a conventional or SiMOX implanter can be used. Typical oxygen implant dose should be $< 1\text{E}17\text{ cm}^{-2}$. For step (iv) conventional furnaces or those used for SiMOX annealing can be used.

Figures below show how the invention has been reduced into practice. The first micrograph in each case shows the region which was untreated. It is clear that the present invention has a profound effect on the formation a continuous and thin buried oxide



Z5X-063001A1-203.t Z5X-063001A1-200.t

Z5X-200 shows discontinuous buried oxide. This region did not receive any porous-Si treatment.
Z5X-2003 shows a thin and continuous buried oxide. This region did receive the porous-Si treatment.
Oxygen dose in both cases is $5\text{E}16\text{ cm}^{-2}$ at 210 keV



ICX-063001A1-203.t

ICX-203 shows a thin and continuous buried oxide. This region did receive the porous-Si treatment.
Oxygen dose in this case is $1\text{E}17\text{ cm}^{-2}$ at 210 keV

Major Claims

1. A method to form ultrathin buried oxide layers by implanting oxygen into a Si substrate containing a buried vacancy-rich region, and annealing the said structure at temperatures of $> 1100^\circ\text{C}$.
2. Controlling the oxide thickness by the implanted oxygen dose.

3. Controlling the oxide thickness by internal thermal oxidation.

2. How does the invention solve the problem or achieve an advantage, (a description of "the invention", including figures inline as appropriate)?
The invention opens up new frontiers in Si technology for multiple applications, such as, buried ground plane MOSFETs, Double gate MOSFETs etc. The process is quite manufacturable and therefore can be applied to IBM's future product lines.

3. If the same advantage or problem has been identified by others (inside/outside IBM), how have those others solved it and does your solution differ and why is it better?
The others have not yet been able to solve this problem.

4. If the invention is implemented in a product or prototype, include technical details, purpose, disclosure details to others and the date of that implementation.
CMOS 11S and beyond technology generation

***Critical Questions (Questions 1-9 must be answered in English)**

***Question 1**

On what date was the invention workable? **Please format the date as MM/DD/YYYY**
(Workable means i.e. when you know that your design will solve the problem)

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Is there any planned or actual publication or disclosure of your invention to anyone outside IBM? ☐ Yes ☒ No

If yes, Enter the name of each publication or patent and the date published below.

Publication/Patent:

Date Published or issued:

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***Question 3**

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Version/Release:

Code Name:

Date:

To Whom:

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☐ Yes
☒ No

If yes, identify individuals and date discussed. Fill in the text area with the following information, the names of the individuals, the employer, date discussed, under CDA, and CDA #.

***Question 6**

Was the invention, in any way, started or developed under a government contract or project?

☐ Yes
☒ No
☐ Not sure

If Yes, enter the contract number

***Question 7**

Was the invention made in the course of any alliance, joint development or other contract activities?

☐ Yes
☒ No
☐ Not Sure

If Yes, enter the following:

Name of Alliance, Contractor or Joint Developer

Contract ID number

Relationship contact name

Relationship contact E-mail

Relationship contact phone

***Question 8**

Have you, or any of the other inventors, submitted this same invention disclosure or similar invention disclosure previously?

☐ Yes
☒ No

If Yes, please provide disclosure number below:

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Question 10

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- ☐ Manufacturers of enterprise servers
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- ☐ Manufacturers of workstations
- ☐ Manufacturers of PCs
- ☐ Non-computer manufacturers
- ☐ Developers of operating systems
- ☐ Developers of networking software
- ☐ Developers of application software
- ☐ Integrated solution providers
- ☐ Service providers
- ☐ Other (Please specify below)

Question 11

If the invention relates to a product or service that is outside the scope of your business unit, please recommend IBM business unit(s), IBM location(s) or individual(s) within IBM that you think would provide a good evaluation of your invention:

n/a

*Patent Value Tool (Optional - this may be used by the inventor and attorney to assist with the eval

(The Patent Value tool can be used by the inventor(s) to determine the potential licensing value of your invention.)

Market

*Question 1: What is the anticipated annual market size (in dollars) that will be captured by your invention?

Greater than \$5B

Reason(s) for above Answer:

Claims

*Question 1: How new is the technical field?

Future

Reason(s) for above Answer:

*Question 2: How central is the invention to the product(s) which might be expected to contain the invention?

Main

Reason(s) for above Answer:

*Question 3: What is the scope of the claim?

Fundamental

Reason(s) for above Answer:

Portfolio Need

*Question 1: What are the portfolio needs in the area of your invention?

Listed In PPM Needs

Reason(s) for above Answer:

Exploitation & Enforcement

*Question 1: How easily can the use of the invention by a competitor be detected?

With work

Reason(s) for above Answer:

*Question 2: How easily can the use of the invention be avoided by a competitor?

Will much work

Reason(s) for above Answer:

Business Value

*Question 1: What percentage of the companies producing products in the field of this invention might use this invention?

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Reason(s) for above Answer:

*Question 2: What is the value of this patent to current or anticipated Alliance Activity between IBM and other companies?

High value

Reason(s) for above Answer:

*Question 3: What is the value of this patent to current or anticipated Technology Transfer Activity between IBM and other companies?

High value

Reason(s) for above Answer:

*Question 4: Does it result in prestige to IBM?

Industry wide

Reason(s) for above Answer:

Final Decision

This decision was entered by

Decision: File/Merge

Status: N/A

Merged with disclosure number : YOR8-2001-0417

Date of Final Decision :

Additional filing information

Planned Filing date:

Filing comments:

Additional decision comments

Final Decision History

Entered on :

File/Merged with: YOR8-2001-0417

Docket(s) Family: YOR920030293

Post Disclosure Text & Drawings

To add additional information related to this disclosure once it has been submitted, click the action button below and a new document will be opened for you to enter the new information. To view existing post disclosure information, double-click on the item in the list below (if there has been additional information entered), and the document will open for you to view.

Date entered Post disclosure information (comments and drawings)

Form Revised 09/01/02)

41
 B_{H1}

H 3 = 124 nm

H 2 = 36 nm

H 1 = 1.368 μ m

ICX-063001A1-2

Mag = 21.54 K X

200nm
H1

EHT = 10.00 kV

WD = 2 mm

Date

File Name = ICX-063001A1-203.tif

POROUS AREA

H 1 = 12 nm

Z5X-063001A1-2

Mag = 46.31 K X

100nm
H

EHT = 10.00 kV
WD = 3 mm

Date
File Name = Z5X-063001A1-203.tif

NON-POUROUS SIDE

H 1 = 174 nm

H 2 = 76 nm

Z5X-063001A1-2

Mag = 30.71 K X

300nm

EHT = 10.00 kV

Date

WD = 3 mm

File Name = Z5X-063001A1-200.tif